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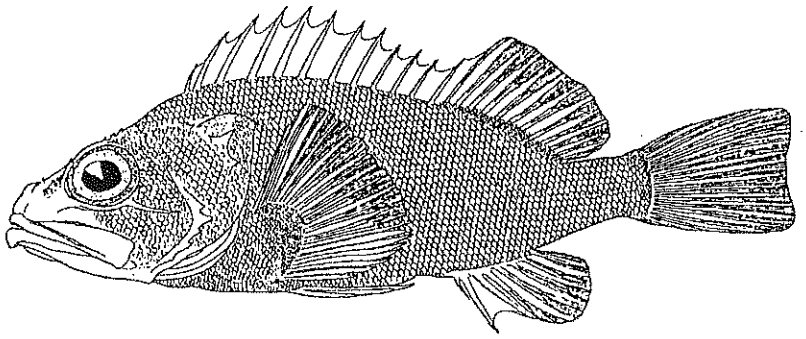

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SAMPLING SURVEYS FOR DEEP-WATER DEMERSAL FISH IN 1993

by

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SUMMARY

Potential for new developments in deep water fishing have been identified by two sampling surveys carried out in April and September 1993, in the deep waters off the west coast of Ireland and Scotland. The primary objective of the two surveys was to secure samples of a variety of potentially commercial deep water fish species in order to examine aspects of their age, growth, reproduction and diet. These data will be essential in formulating management plans for the expanding deep water fisheries in the area. The surveys were conducted on a chartered fishing vessel using a commercial otter trawl, fitted with a small mesh cod-end liner. Fishing activity concentrated on the depth range 400m-1200m and a total of 81 trawling operations were carried out, of which 75 produced fish catches with limited gear damage. Fifteen species of cartilaginous and 50 species of teleost fish were recorded from the catches. These include the roundnose grenadier *Coryphaenoides rupestris*, black scabbard *Aphanopus carbo*, greater forkbeard *Phycis blennoides*, blue-mouth rockfish *Helicolenus dactylopterus* and Baird's smooth-head *Alepocephalus bairdii*. Length, weight, sex, maturity and catch data together with samples of otoliths, gonads and stomachs were secured. In general terms, the fishing ground off the north west of Ireland and west of Scotland caused little problems with gear damage and yielded good catches of deep water species. The two surveys have shown the areas have potential for commercial deep water fishing but the development of this fishery in the area will be contingent on the establishment of suitable markets. This initial report documents the surveys and presents some preliminary results. The data gathered from these surveys are currently under analysis at the FRC and the results will be published in the scientific literature.

INTRODUCTION

Pressure on inshore fish stocks has led to the exploitation of deep water demersal fish in the waters of the continental slope, to the west of Ireland and Scotland. This has been reflected in the numerous articles that have appeared in recent editions of the Irish, French and U.K. fishing press (e.g. Anon. 1993a; 1993b; McCormick 1992a; 1992b; Gordon, 1992). Deep water fishing has been carried out for some years in the north west Atlantic and have mainly targeted Greenland halibut (*Reinhardtius hippoglossoides*) and redfish (*Sebastes* species). Deep water long lining has been traditionally carried out off the coast of Norway, north Iceland and Greenland, mainly for Greenland halibut and blue ling while a traditional Portuguese long line fishery for black scabbard is well established in the area to the north of Madeira. The orange roughy has been fished commercially off the coast of New Zealand and Australia for some time and there are now concerns that the stocks are over fished and in decline. The new deep water fisheries of the north-east Atlantic, however, are focused on a wider range of species such as orange roughy, rabbitfish (*Chimaera monstrosa, Hydrolagus mirabilis*), roundnose grenadier, blue ling, black scabbard, greater forkbeard, greater argentine and deep water sharks (principally *Centroscymnus coelolepis* and *Deania calcea*). Further north in the long line fisheries the rough-head grenadier, deep water cod, and deep water sharks are the most important species.

In recent years, there has been an increasing number of French, Faroese and Icelandic commercial vessels testing the potential for deep water fishing to the west of the British Isles and in the waters of south Iceland and south Faroes. Markets have been developed in France and to a lesser extent in the US and considerable potential now exists for the fishery. In 1993, the ICES north-western Working Group, (Anon. 1993d) summarised available information on the fishing activity of the various fleets (Faroese, France, Germany, Greenland, Iceland, Norway and Russia) targeting deep water species. These data indicated that the landings of *some* of the main commercial deep water species (orange roughy, black scabbard, greater forkbeard) in 1992 were at least 14,000 tonnes and suggested these species were being heavily exploited while we know little about the basic biological parameters of the stocks.

The main species targeted by the project are orange roughy, roundnose grenadier, rabbitfish, black scabbard, greater forkbeard, redfish (*Helicolenus dactylopterus* and *Sebastes mentella*), blue ling, deep water cod and baird's smooth-heads; (aspects of the biology of the greater argentine have been investigated in a separate EC FAR funded project conducted by the Fisheries Research Centre in 1993). The most important initial objective of the project was to secure adequate samples from a variety of these deep water species for ageing, growth, reproductive and dietary analyses. Consequently, two 14 days sampling surveys were carried out, the first in April and the second in September 1993. This report outlines the survey preparation and some basic survey results from these two sampling surveys, which were carried out by the commercial whitefish trawler, the *Mary M.* The data from these surveys will be analysed under an EC STRIDE funded, post

graduate studentship scheme between the FRC and the Zoology Department, University College, Dublin. When these data are fully analysed, the results will be initially presented in thesis and report formats and finally published in the scientific literature.

Dr John Gordon (Scottish Association for Marine Science) an expert in the area of deep water fish ecology took part in the September survey.

PERSONNEL

April Survey (12-28 April 1993)
Part One 12th to 20th April, Part Two 19th to 28th April 1993

September Survey (5-18 September 1993)
Part One 5th to 10th September, Part Two 11th to 18th September 1993

P. Connolly	FRC, Demersal Section	Chief Scientist; Part One April, Entire survey September
J. Molloy	FRC, Pelagic Section	Chief Scientist; Part Two April
H. Mc Cormick	FRC, Demersal Section	Part One April
J. Daly	FRC, FAR Argentine Project	Entire Survey April and September
C. Kelly	FRC, STRIDE Deep Water Project	Entire Survey April and September
J. Gordon	SAMS, Oban, Scotland	Entire Survey September
H. Hunter	SAMS, Oban, Scotland	Entire Survey September

SURVEY AREA AND TRAWL POSITIONS

April Survey

The target area for the first sampling survey was in the Continental Slope area north of 50° N and south of 58°N (ICES Divisions VIa, VIIb, VIIj;) over the depth range 500 to 1,200 m. The total sea floor area within the Irish EEZ (Exclusive Economic Zone), between 500 and 1,500m, amounts to 30,922 square km (Figure 1). The selection of specific target areas and suitable trawl positions was of paramount importance to the success of this sampling survey and therefore, a considerable amount of time was spent collating data on potential trawl positions, fishing grounds and catch information. The prime considerations were to locate 'safe' tow positions which would minimise gear damage, yield good catches of a variety of deep water species and survey as wide an area as possible. Given these selection criteria, the cruise reports and vessel logbooks from surveys that had previously been carried out in the deep waters of the north east Atlantic, between 50° N and 57° N, were examined and a reservoir of possible sites was established (Holt & Byrne, 1906a; 1906b; 1908; Anon. 1974; Bridger, 1978; Ratz, 1984; Merrett et al. 1991; Connolly, 1992). These papers detail the catches of deep water species and are a valuable source of tow positions and information on bottom types. The pioneering

work of Holt and Byrne at the turn of this century, stands as an important milestone in the description of the Irish continental slope ichthyofauna.

The surveys examined are listed below.

Country	Vessel	Year	Area
Ireland	Helga	1904 - 1912	Porcupine
UK.	Florence Brierly	1928	Rockall
UK.	Swanella	1973	Porcupine Rockall
UK.	Cirolana	1973 - 1974	Porcupine Rockall
UK.	Luneda	1974	Rockall
UK.	Discovery	1977 - 1978	Porcupine
UK.	Challenger	1977 - 1985	Porcupine Rockall
Germany	Walther Herwig	1974-1980	Rockall

After detailed analyses of these data, the specific areas to be surveyed were selected and divided into eight boxes, each containing a set of trawl stations that fulfilled the selection criteria outlined above. These eight areas are shown in Figure 2. It became evident during the collation of the trawl positions and following consultations with the skipper of the *Mary M*, that for a variety of reasons, it would not be possible to reproduce these tows exactly while at sea. Many tows only gave a shoot position while others were given in DECCA chains that had since been changed and strengthened. Different positional instruments were also used by the various surveys and it was decided that the reservoir of tows would provide us with areas on which to focus our fishing efforts rather than with specific tows.

One of the objectives of the April survey was to secure samples of argentine for the EC FAR argentine project. The sampling design therefore involved the selection of a series of 'shallow water' stations, in the depth range 300 to 500m for inclusion in the April survey programme.

September Survey

The September survey concentrated on the areas fished in Part one of the April survey (Areas 1 to 4), but did not include any of the shallower tows (<560m) fished on the April survey. Furthermore, the range of the survey was extended into ICES Division VIb, to include three areas around the Rockall Plateau. The same selection criteria as outlined for the April survey were used to select potential trawling positions at Rockall. When plotted, the tow positions from previous surveys were dispersed around the Rockall Plateau and did not indicate clear clustering areas upon which to focus fishing activity. However, three areas, north Rockall, south-east Rockall and south Rockall (Areas 9 to 11) were selected and targeted for fishing. The areas around the Porcupine Bank (i.e. Areas 5 to 8) were not fished during the September survey. The September survey also examined the potential use of fish traps (steel cages) for deep water fishing.

PROCEDURES

The initial sampling design was to tow for 1 hour at each station selected for trawling. However, during the April survey, it became apparent that this would not be possible or feasible and the trawl duration evolved on a tow by tow basis. Consequently, the trawl durations ranged from approximately one hour to four hours. At each station, the position shot and hauled and the depth shot and hauled were noted. The ground trawled was monitored during each tow on the colour sounder, together with the warp lengths and tensions.

The catch was lowered into the stern fish deck and a note was made of the main species. Fish were identified using the UNESCO, *Fishes of the North-eastern Atlantic and Mediterranean*, Volumes 1 to 3 , the FAO *Species Catalogues for Gadiform fish* and *Sharks of the World* by L. J. V. Compagno. Species that could not be identified on board ship were frozen for later identification at the FRC. All large fish were removed and boxed while the smaller fish were placed on a conveyor belt and sorted by species or family groups. The total number of boxes from the haul was then recorded by species, and a selection of boxed fish was weighed to estimate the catch weight of each species. A number of specimens at each station were measured, weighed, sexed and staged for maturity. Otoliths were stored dry while stomachs and gonads were preserved in 10% saline formalin for histology samples and Gilson's fluid for fecundity estimates.

The total length of grenadier and rabbitfish could not be measured due to the difficulties in ascertaining the tip of the ribbon like tail, which is extremely narrow and becomes damaged in the trawl. Consequently the pre-anus length (not pre-anal fin length) was used. Selected samples were also frozen for later analyses at the FRC (30 boxes in April and 54 boxes in September). The differential weights generated from fresh, iced and frozen samples will be examined and length-weight conversion equations will be derived.

A selection of fillets was frozen from rabbitfish, roundnose grenadier, greater forkbeard, blue ling, black scabbard and baird's smooth-head for food properties analyses by the National Food Centre, and for heavy metal analyses by the FRC. The results of the food analyses were published in Gormley *et al.* (1994).

RESULTS

April Survey

Details of the trawls carried out during the April survey are presented in Table 1 and a list of the species encountered are given in Table 3. Part one of the survey encountered some gear damage, but fishing was generally good and a large number of samples and valuable data were collected. However, the ground selected for the second part of the survey turned out to be very bad and a considerable amount of gear damage occurred. To reduce gear damage, the fishing areas were modified and expanded to cover tows outside Areas 5 and 8, while fishing in Area 6 was abandoned and redirected to a new area 5(2) (Figure 2).

April Survey Part 1

Area 1 (12/4/93) Personnel arrived in Killybegs and gear was loaded onto the vessel. The *Mary M* departed Killybegs at 19.00 hrs. A meeting was held with the skipper to discuss the general survey plan over the first part of the survey. Weather was ideal (force 2-3) and the *Mary M* proceeded to Area 1 off the Hebrides, Scotland.

Area 1 (13/4/93) Weather was very good (force 2-3, north-west). There were a considerable number of French and Norwegian boats in the area fishing both deep water and pelagic species. Haul 1 was made in 422 m. There was a large catch of greater argentines, greater forkbeards and monkfish. Hauls 2 to 5 were completed in the depth range 400-670 m, over sandy and muddy ground and there were again good catches of greater argentines, monk, megrim, greater forkbeards, blue ling and ling. There was no gear damage.

Area 1 (14/4/93) Weather was good (force 3-4, north-east). French and Norwegian boats continue to fish in the area. Hauls 6 to 10 were completed in the depth range 700 to 910m over sandy and muddy ground and there were good catches of deep water species (greater forkbeard, roundnose grenadiers, greater argentines, redfish). Catches of monk, ling, and saithe were also good. The gear was not damaged.

Area 2 (15/4/93) The weather was freshening (force 4-5, south-west). There was severe gear damage to the trawl at Haul 11 and the net could not be repaired at sea. The cod end liner was lost. The vessel proceeded to Area 2. Hauls 12 to 13 were completed in the depth range 360 to 567 m over sandy, steep ground. There were poor catches of deep water species, but fair catches of hake, ling and monk. There were a large number of French boats in the area and towards nightfall we decided to follow these into shallower water (250-350 m) to see what the catches were. Haul 14 was made in 360 m and there were very good catches of cod, monk, megrim and ling. The trawl net and second cod end liner were badly torn at Haul 14 but were repaired by the crew.

Area 2 (16/4/93) Weather was good (force 3-4, south-west). Hauls 15 to 18 were completed in the depth range 509 to 873 m and catches were not very good. However, samples of black scabbard, greater forkbeards, blue ling and greater argentines were examined. There was no gear damage.

Area 3 (17/4/93) Weather was good (force 5, north-west). Hauls 19 to 25 were completed in the depth range 300 to 937 m and there were good catches of rabbitfish, Baird's smooth-heads (spawning), roundnose grenadiers and other mixed deep water species. There was no gear damage.

Areas 3 and 4 (18/4/93) Weather was deteriorating (force 4-5, north-west) and southerly gales were forecast. Hauls 26 and 27 were completed in the depth range 364 to 553 m and there were good catches of rabbitfish, redfish, ling, hake, saithe and monk. There was no gear damage over these tows.

Area 4 (19/4/93) Hauls 28 to 31 were completed in the depth range 740 to 819 m and there were very good catches of black scabbard, roundnose grenadier, redfish over the stony and muddy ground. There was limited gear damage. However, on the last tow, the gear became stuck and the starboard warp broke. It took several hours to retrieve the gear. It was decided to finish part 1 of the survey and return to Killybegs to repair the trawl gear, unload frozen samples and change personnel. The *Mary M* berthed in Killybegs at 9.30 am on 20/4/93.

Killybegs (20/4/93) Unloaded gear and samples, repaired nets.

Killybegs (21/4/93) Loaded boat. Finished repairing gear. Departed at 12:00.

April Survey Part 2

Area 5 (22/4/93) Weather was favourable with a force 5 north-west wind. A meeting was held with the skipper to discuss the survey plan for the second part of the survey. Hauls 32 to 34 were completed in the depth range 500 to 906m. The ground proved to be very hard and there was severe gear damage caused by coral and the gear becoming stuck. There were no commercial quantities of fish taken. There were small catches of shark species, greater forkbeards, redfish and rabbitfish. To avoid further gear damage we decided to leave Area 5. The *Mary M* steamed for Rossaveel, Co. Galway to let one of the crew ashore. The vessel then sailed for Area 8.

Area 8 (23/4/93). Weather conditions were good (force 5 north-west). Haul 35 was completed in 520 m of water. The catch was very poor and the gear continued to come fast and suffer more damage.

Area 8 and 7 (24/4/93). Weather conditions were fair (force 4-5, north-west). Hauls 36 to 41 were completed in the depth range 600 to 953 m. Catches were poor and composed of many small grenadiers, mixed shark species and redfish. There were also some small fish that were frozen for later identification at the FRC. The net was badly damaged at Haul 39.

Area 7 (25/4/93). Hauls 42 and 43 were completed in the depth range 600 to 635m. Catches were very poor and mainly composed of small grenadier and a mixture of shark species. The net was severely damaged when hauled from Haul 43. With only one remaining net, it was decided to leave Area 7 and go north, to trawl the new Area 5(2).

Area 5(2) (26/4/93). Weather was good (force 2-3, north-east). Hauls 44 to 48 were completed in the depth range 280 to 658 m. Catches were small and the main species were rabbitfish, redfish and grenadiers. The last remaining net was severely damaged at Haul 48 and the *Mary M* abandoned all fishing and headed for Killybegs berthing at 07:30 hrs on the 27 April.

Catch from the April Survey

A total of 31.29 tonnes of fish was taken over the entire survey. Area 4 had the highest catch rates for rabbitfish (132 kg/hr) and black scabbard (178 kg/hr), while Area 7 had the highest catch rates for grenadier (38 kg/hr). Smooth-head species had highest catch rates in Area 3 (91 kg/hr), while Area 1 had highest catch rates for blue ling (73 kg/hr). Forkbeards had highest catch rates in Areas 2 and 4.

Area 1 produced by far the highest catches (12.4 tonnes) over the depth range fished (422-910 m), with greater argentine (4,455 kg), blue ling (1,980 kg), monk (1,575 kg), ling (945 kg), saithe 450 kg) and hake (338 kg) dominating the catch. There were also good catches of the targeted deep water species, with 639 kg of mixed redfish, 383 kg of rabbitfish. 225 kg of greater forkbeards and 69 kg of grenadiers (mainly roundnose). A total of 27 hours fishing took place in Area 1, yielding a total catch rate of 459 kg/hour.

Area 2 was fished over the depth range (364-873 m) and produced 2.3 tonnes of fish for a total of 15 hours fishing. Catches were dominated by shark species (675 kg), hake (383 kg) and saithe (360 kg). Targeted deep water species were also taken in good quantities (greater forkbeards 180 kg, black scabbard 168 kg, rabbitfish 68 kg). The total catch rate for Area 2 was 155 kg/hour.

The total catch from Area 3 amounted to 4.6 tonnes for 17 hours fishing (272 kg/hour). This Area was fished over the depth range 300-937 m. Baird's smooth-heads and rabbitfish dominated the catch at 1,530 kg and 1,077 kg respectively. Catches of hake (383 kg), saithe (315 kg), monk (248 kg) and shark species (495 kg) were also good.

Area 4 was fished over the depth range 364-818 m and produced 6.8 tonnes of fish, with black scabbard (2,438 kg) and rabbitfish (1,818 kg) dominating the catch. A total of 14 hours was fished in this area, yielding a catch rate of 485.7 kg/hour.

The catches in Area 5, which was fished over the depth range 506-906 m, were dominated by shark species (1,687 kg). Catches of rabbitfish were 500 kg, with redfish at 140 kg. A total of 4 hours was fished in this area giving a catch rate of 628.3 kg/hour.

Area 7 produced a total catch of 1.1 tonnes for 9 hours fishing (120 kg/hour). Shark species (448 kg) and grenadiers (344 kg) dominated the catches. This area was fished over the depth range 609-850 m.

A total of 7 hours fishing took place in Area 8 over the depth range 520-953 m and this produced a catch of 0.6 tonnes (84.6 kg/hour). The species composition of the catches here were very poor with shark species (337 kg) and grenadiers most abundant.

Area 5(2) produced 1 tonne of fish for 9 hours of fishing (106 kg/hour) with redfish species (304 kg) and rabbitfish (472 kg) dominating the catches.

No orange roughy were taken on this survey.

September Survey

The details of the trawls are given in Table 2. Part one of the September survey (5th to 10th September) produced very good caches of roundnose grenadier and shark species, with smaller catches of black scabbard . Areas 1, 2, 3 and 4 displayed considerable potential for commercial deep water fishing. The first catches of orange roughy were taken off the Hebrides Terrace Seamount, and smaller numbers were taken at Haul 29. There was no gear damage and the ground fished was good. The second part of the survey focused on Rockall and catch rates here were disappointing. There were considerable problems with coral and minor gear damage occurred.

September survey Part 1

Area 2 (5/9/93). Personnel arrived in Killybegs and the gear was loaded. *Mary M* sailed at midnight and steamed for Area 2 to commence fishing.

Area 2 (6/9/93). Weather conditions remained perfect (force 3-4; east-south-east). Shot one cage at position 56.11.72 N and 9.09.93 W at midday. Hauls 1, 2 and 3 were completed in the depth range 628 to 833 m. The ground was composed of sand/mud and there was no gear damage. Catches of roundnose grenadier were very good at Haul 2 while there were good catches of shark species at Haul 3.

Areas 2 and 1 (7/9/93). Weather remained very calm (force 3-4; south south-east). Hauls 4, 5, 6, 7, 8, and 9 were completed in the depth ranges 563 m to 1,026 m. Catches of roundnose grenadier were good from Hauls 7 to 9.

Areas 2 and 1 (8/9/93). Weather remained good (force 3-4; south-west). The doors tangled while shooting Haul 10 and the tow was abandoned. Haul 11 was shot in 1,116 m and yielded good catches of grenadier. Haul 12 was carried out on the Hebrides Terrace Seamount at a depth of 1,148 m and yielded a small catch of orange roughy and large catch of Baird's smooth-heads.

Areas 3 and 2 (9/9/93). Weather conditions were good (force 2-3; east south-east). Hauls 13 to 16 were completed in the depth range of 715 m to 918 m. Catches were moderate except for a very good catch of roundnose grenadier at Haul 16. There was no gear damage but the doors stuck in the mud during Haul 15 and the gear was hauled early.

Areas 3 and 4 (10/9/93). Hauls 17 to 21 were fished over the depth range of 720 m to 1,044 m. Good catches of roundnose grenadier were recorded from Haul 17, 18, 19, 20 and 21 and this area showed considerable potential for commercial fishing. The cage

was shot at a depth of 400m at position 55° N and 10° W. The weather conditions were freshening (force 3-4 north-east) as the vessel steamed for Killybegs.

Killybegs (11/9/93). The *Mary M* developed propeller problems and berthed off the pier at 08.00. Divers found a large amount of rope tangled around the shaft and this was removed. The vessel berthed Killybegs at 10.00 hrs. The catch of deep water fish was unloaded for export to France and the crew was changed.

September survey Part 2

Killybegs (12/9/93). The *Mary M* departed Killybegs at 12.00 hrs and steamed for Rockall. The cage was retrieved and while all the bait had been eaten by deep sea amphipods, there was no catch.

Area 9 (13/9/93). Weather conditions were perfect (force 3; east). Hauls 22 and 23 were fished north of the Rockall Plateau in the depth range 455 to 1,021 m. The bridle broke during Haul 22 and the gear was hauled early. Catches were poor

Area 9 (14/9/93). Hauls 24 to 27 were completed in the depth ranges 576 to 936 m. There were good catches of grenadier and mixed shark species at Hauls 26 and 27. the weather conditions were good (force 2-3; north-west). The ground fished presented no problems and there was no gear damage.

Areas 10 and 11 (15/9/93). Weather conditions were perfect (force 2-3; north-west). Hauls 28 and 29 were fished in south east Rockall. The ground was very hard and the gear came fast due to the abundant coral. Catches were poor and it was decided to leave the area and go to Area 11 (south Rockall). Hauls 30 to 32 were fished in the depth range 684 to 958 m and catches were poor. The gear came fast during each tow and it was decided to leave the area and return to Area 4.

Area 4 (16/9/93). Weather conditions remained good (force 2-3; north-west). The *Mary M* steamed to Area 4. Haul 34 was fished in 1,015 m and produced very good catches of grenadier and shark . Three French boats were fishing in the area.

Area 4 (17/9/93). Weather conditions were good (force 3-4; south east). Hauls 35 to 38 were fished in the depth range 927 m to 1,085 m and produced very good catches of grenadier and black scabbard. There was a large catch of Baird's smooth-heads from Haul 36. The *Mary M* steamed for Killybegs.

Killybegs (18/9/93). The 'Mary M' berthed at Killybegs at 09.30.

Catch from the September survey

A total of 52.07 tonnes of fish was taken over the entire survey. There were considerable difficulties in identifying the various shark species on the April survey. Most effort was concentrated on the identification of the bony fish species, leaving little time to key out and identify the various sharks. However, on the September survey we drew on the expertise of Dr. John Gordon and more time was allocated to the identification of shark species and in estimating their relative abundance at each station. There were also difficulties in allocating time to the identification of Cephalopod and ray species taken during the April and September surveys. Therefore these species have not been included in the catch analyses presented in this report. A selection of Cephalopods and rays were frozen and these will be identified at a later stage.

In general, the catch rates in September were higher than those taken on the April survey. Areas 1 to 4 produced good catch rates of grenadiers (168-368 kg/hour). These were much higher than the April catch rates from the same areas (0-22.3 kg/hour). The black scabbard catches were highest in Area 4 (27.5 kg/hour), much lower than the catch rates observed in April, from the same area (177.9 kg/hour). In September, Area 4 produced highest catch rates of smooth-heads (123.2 kg/hour) and blue ling (22.0 kg/hour). The south Rockall area yielded highest catch rates for shark species (113.1 kg/hour), rabbitfish (68.0 kg/hour) and deep water cod (27.4 kg/hour).

CONCLUSIONS

The only ground covered on both the April and September surveys were the tows in areas 1 to 4, consequently it is only possible to compare the results from these areas.

There were considerable problems with the ground trawled in Areas 5, 6, 7 and 8 during the April survey and this resulted in extensive gear damage. Except for sharks, catches of potentially commercial deep water species were not very encouraging, although various deep water species of scientific interest and which were not seen in seen in Areas 1 to 4 were taken. If commercial deep water trawling is to be developed in the areas off the west and south west coast of Ireland, further work will have to be carried out to identify potential trawling sites and to examine catches and yields from these sites. If the ground in these areas proves unsuitable for commercial trawling operations, there may be considerable scope for exploratory long lining and future survey work should also be directed at this type of fishing.

The trawling sites examined in the Rockall area produced moderate catches of deep water fish but caused considerable problems with trawling operations. Further work should be directed at identifying suitable trawling areas and in examining catch rates of deep water species from a wider area of the Rockall Plateau.

ACKNOWLEDGEMENTS

The success of the 1993 deep water sampling survey programme was due to the help and co-operation we received from a variety of individuals and organisations. We would like to express our gratitude to Mr Richard McCormick, Irish Sea Fisheries Board (BIM), Dublin, for his expert advice and help and for providing us with useful charts of the areas. We would like to thank Dr Joe Horwood, MAFF, Fisheries Laboratory, Lowestoft, UK, for his suggestions and for providing us with a series of possible tow positions for the cruise. Dr John Gordon, Scottish Association for Marine Science, Oban, UK, provided us with trawl positions from previous surveys and with much helpful literature. During the September cruise we continuously drew on his expertise and wealth of knowledge to help identify and confirm the identification of a wide variety of the deep water species taken on both the April and September surveys. We are grateful to Mr Yves Coupez, FRC, GIS Scientist, for his advice and work on data presentation for this report. Mr John Molloy (FRC), as always, provided us with invaluable advice and was chief scientist on part two of the April survey. Finally, we would like to thank the skipper (Mr Jim Murrin) and crew of the *Mary M* for all their co-operation and help during the two voyages.

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Figure 1. Boundaries of Irish EEZ and ICES Areas, ground between 500 and 1,500 m shaded.

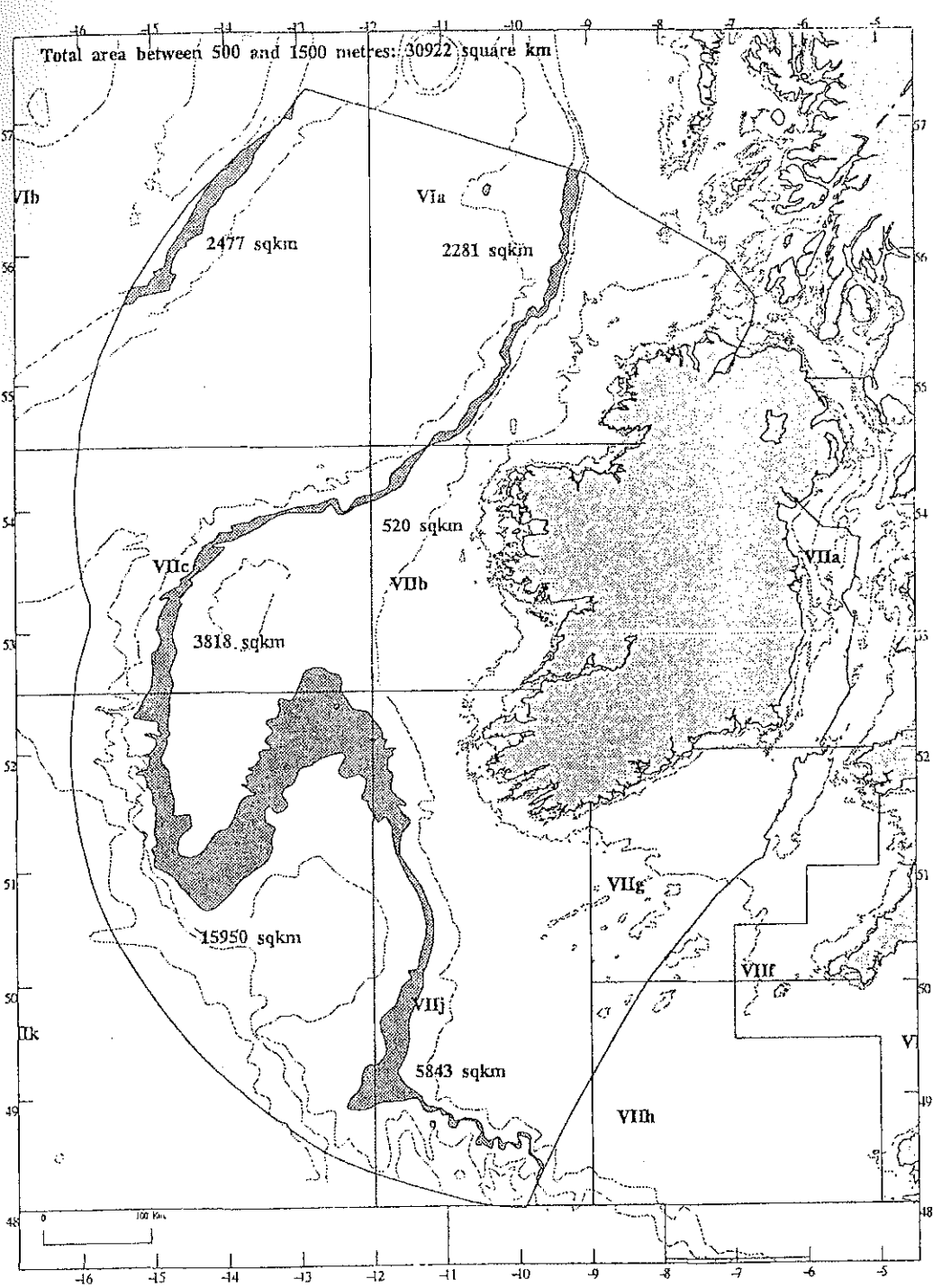

Figure 2. Areas selected for sampling (shaded) with trawl tracks.

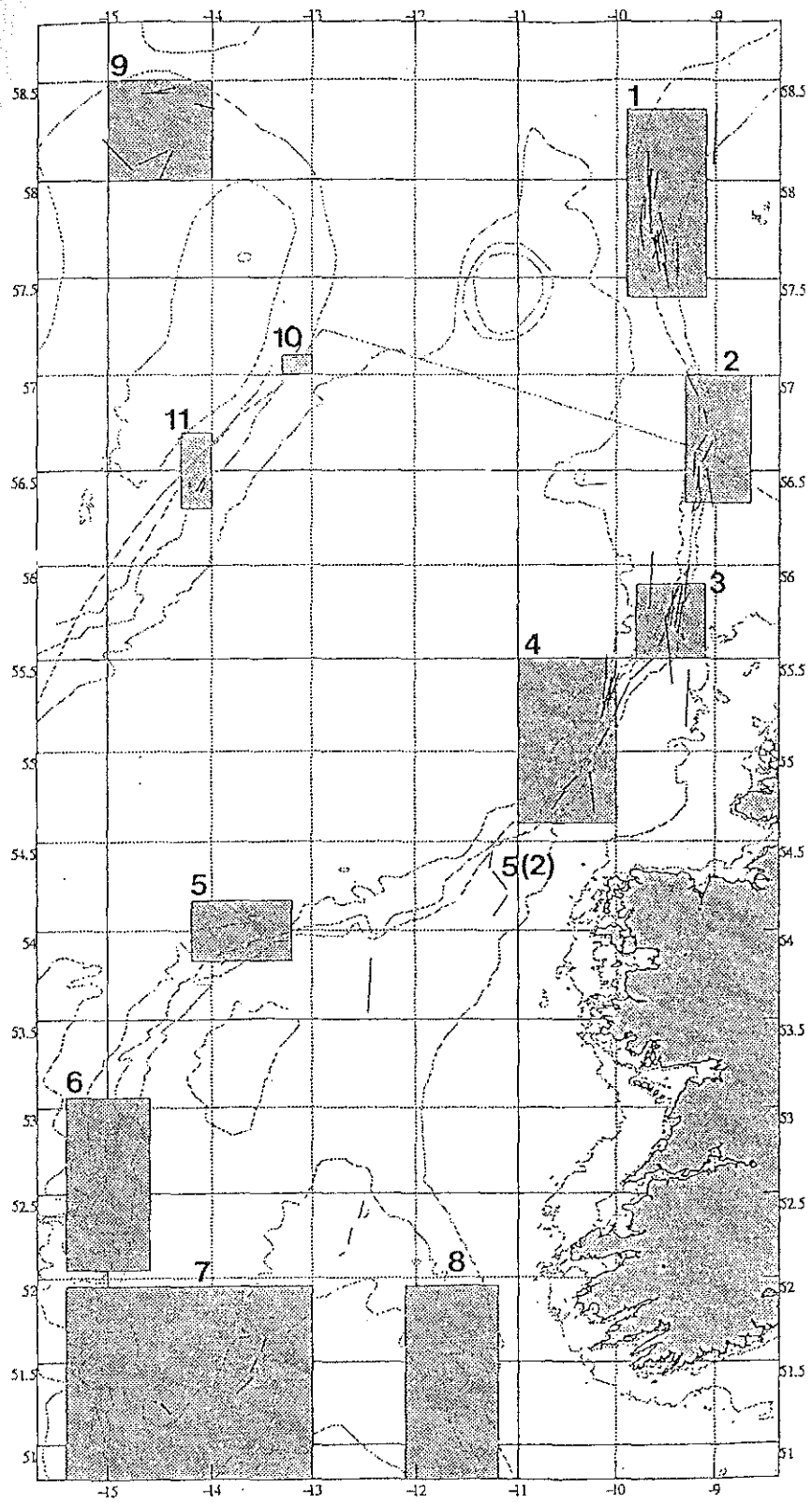

Table 1 Station positions for sampling survey of *Mary M* 13-28 April

STATION	AREA	DEPTH (m)	WARP (m)	HAUL DURATION	POSITION SHOT LAT	POSITION SHOT LONG	POSITION HAULED LAT	POSITION HAULED LONG	CATCH (Kgs)	COMMENTS
1	1	422	955	01:30	57.28.85	9.29.62	57.35.00	9.31.79	975	megrim
2	1	477	1001	01:50	57.31.81	9.33.49	57.44.66	9.35.52	968	argentines
3	1	539	1183	01:52	57.43.40	9.36.92	57.36.64	9.35.39	698	argentines
4	1	573	1237	04:15	57.38.50	9.36.60	57.35.85	9.38.48	1845	french trawlers in area
5	1	670	1365	03:00	57.52.36	9.39.81	57.43.31	9.38.89	2341	blue ling
6	1	746	1441	02:00	57.45.04	9.39.46	57.53.07	9.40.88	630	blue ling
7	1	819	1528	02:00	57.56.46	9.41.10	58.08.55	9.40.99	630	french trawlers in area
8	1	910	1638	02:00	58.01.55	9.40.41	57.56.07	9.40.30	203	rabbitfish
9	1	900	1619	02:15	57.54.58	9.42.00	57.48.08	9.43.00	2205	argentines
10	1	709	1501	05:00	57.47.50	9.40.00	58.03.49	9.39.26	1385	argentines
11	1	546	1274	02:20	58.01.93	9.35.00	57.54.15	9.37.55	531	net torn
12	2	455	955	01:10	56.41.41	9.00.46	56.39.63	9.00.06	930	french trawlers in area
13	2	567	1201	02:30	56.38.71	9.02.22	56.32.52	9.08.61	337	hake
14	2	364	728	04:20	56.30.67	9.05.00	56.18.66	9.01.66	45	net torn
15	2	773	1501	02:00	56.24.33	9.10.19	56.31.45	9.09.77	236	black scabbard
16	2	809	1601	02:00	56.29.40	9.10.40	56.24.12	9.11.28	360	hard ground
17	2	873	1619	02:00	56.21.28	9.11.82	56.16.46	9.14.34	451	shark
18	2	509	1092	01:10	56.18.00	9.10.55	56.21.09	9.08.39	272	shark
19	3	300	719	00:30	55.50.80	9.17.60	55.48.96	9.18.00	0	went fast
20	3	437	873	03:25	55.48.29	9.18.48			676	rabbitfish
21	3	606	1201	02:20	55.40.00	9.24.70	55.47.35	9.22.00	833	rabbitfish
22	3	738	1501	02:29	55.46.60	9.24.73	55.40.73	9.26.77	474	rabbitfish
23	3	937	1638	02:05	55.42.17	9.28.15	55.48.58	9.25.80	940	spawning smoothheads
24	3	742	1456	01:55	55.38.94	9.30.22	55.34.26	9.33.93	1125	hilly ground
25	3	437	955	04:00	55.30.00	9.37.48	55.23.18	9.52.30	585	smoothheads
26	4	364	728	04:00	55.22.21	9.50.00	55.11.21	10.01.64	660	net badly torn
27	4	563	1219	02:30	55.07.37	10.04.98	55.01.65	10.10.83	2565	rabbitfish black scabbard
28	4	764	1528	01:15	54.39.58	10.13.58	54.53.17	10.16.12	736	net badly torn
29	4	819	1612	00:40	54.54.90	10.20.91	54.53.18	10.22.03	833	came fast
30	4	773	1592	02:20	54.51.59	10.24.32	54.47.12	10.32.75	1305	rabbitfish black scabbard
31	4	746	1547	02:40	54.46.60	10.31.50	54.40.54	10.39.40	675	came fast
32	5	728	1545	02:18	53.56.42	13.13.78	53.56.25	13.23.19	1085	came fast
33	5	906	1615	01:05	53.50.21	13.50.98	53.48.60	13.54.47	956	came fast
34	5	506	1194	00:30	53.35.14	14.12.17	53.33.83	14.12.73	472	came fast
35	8	520	1135	02:10	52.92.32	12.27.44	52.35.33	12.29.52	112	rabbitfish shark
36	8	655	1565	02:05	52.27.00	12.30.00	52.21.00	12.33.00	180	came fast
37	8	765	1499	02:00	52.17.74	12.36.34	52.11.90	12.38.82	300	grenadiers shark
38	8	953	1635	00:45	52.09.15	12.41.23	52.07.92	12 44.14	0	no catch
39	7	788	1598	02:00	51.38.68	13.27.20	51.33.82	13.30.50	338	grenadiers
40	7	850	1499	02:00	51.31.46	13.33.05	51.26.67	13.37.11	398	grenadiers
41	7	738	1499	02:00	51.24.10	13.35.46	51.18.70	13.44.92	211	grenadiers
42	7	609	1317	02:01	51.11.24	14.24.40	51.15.17	14.29.62	69	grenadiers
43	7	635	1363	00:30	51.16.02	14.32.91	51.15.82	14.34.20	67	net destroyed
44	5(2)	284	705	02:00	54.05.07	11.14.82	54.11.85	11.06.55	0	no catch
45	5(2)	380	817	02:00	54.13.82	11.06.88	54.19.65	11.14.83	0	no catch
46	5(2)	575	1208	02:03	54.21.09	11.16.81	54.26.75	11.15.03	272	rabbitfish
47	5(2)	658	1274	00:32	54.28.45	11.12.23	54.29.33	11.09.68	191	came fast
48	5(2)	542	1270	02:20	54.31.19	11.01.24	54.33.10	10.55.03	495	redfish rabbitfish

Table 2 Station positions for sampling survey of *Mary M* 5-18 September

STATION	AREA	DEPTH (m)	WARP (m)	HAUL DURATION	POSITION SHOT LAT	POSITION SHOT LONG	POSITION HAULED LAT	POSITION HAULED LONG	CATCH (Kgs)	COMMENTS
1	2	628	1341	02:45	56.22.12	9.08.98	56.30.26	9.09.91	461	redfish and sharks
2	2	833	1614	03:03	56.36.33	9.11.37	56.41.24	9.05.74	2248	running grenadiers
3	2	731	1440	01:55	56.44.53	9.05.00	56 49.68	9.07.10	1164	mostly sharks
4	2	1026	1980	03:20	56.53.52	9.10.77	57.01.23	9.17.69	776	grenadiers & scabbards
13	2	833	1755	03:35	56.36.08	9.12.36	56.27.78	9.12.85	736	small mixed catch
5	1	563	1260	03:00	57.32.15	9.33.99	57.42.34	9.37.80	792	mostly rabbit fish
6	1	772	1534	03:10	55.46.00	9.40.00	57.55.23	9.41.51	358	small mixed catch
7	1	862	1737	03:15	57.58.00	9.42.00	58.06.99	9.40.67	816	mostly grenadiers
8	1	925	1912	03:00	58.05.00	9.02.00	57.57.28	9.43.05	1058	caught longlines
9	1	1026	2160	03:15	57.55.00	9.43.50	57.48.20	9.45.27	1500	mostly grenadiers
10	1	1116	2250	03:15	57.46.00	9.46.00	57.38.53	9.43.67	0	foul shot
11	1	1116	2250	03:15	57.41.00	9.45.00	57.50.07	9.45.39	993	mostly grenadiers
12	Hebred. tce	1148	2250	03:10	56.25.77	10.06.21	56.25.18	10.22.92	2543	orange roughy
14	3	715	1199	03:34	55.53.94	9.19.95	55.44.70	9.23.09	860	sebastes mentella
15	3	882	1981	01:45	55.52.00	9.26.00	55.47.00	9.26.30	1069	doors fast
16	3	918	1917	03:00	55.44.00	9.30.00	55.22.00	9.26.00	1643	grenadiers
17	3	943	1953	03:20	55.53.00	9.22.50	55.43.24	9.29.46	1624	mostly grenadiers
18	4	884	2160	03:00	55.25.17	9.57.89	55.15.70	10.04.70	1747	mostly grenadiers
19	4	1017	2125	03:15	55.17.94	10.05.41	55.25.14	9.59.94	1981	mostly grenadiers
20	4	720	1611	03:25	55.29.00	9.59.00	55.14.58	10.05.50	1646	mostly grenadiers
21	4	1044	2155	03:15	55.17.00	10.06.00	55.25.00	10.01.00	970	mostly grenadiers
34	4	1015	2016	05:50	55.11.52	10.09.45	55.23.66	10.02.49	4635	grenadiers& sharks
35	4	927	1933	04:30	55.22.26	10.02.60	55.10.76	10.09.05	1893	mostly grenadiers
36	4	1085	2205	04:00	55.13.51	10.07.26	55.24.21	10.03.03	7341	many smoothheads
37	4	968	1926	04:30	55.24.00	10.01.00	55.13.79	10.08.24	1699	mostly grenadiers
38	4	997	2070	04:00	55.13.00	10.08.00	55.75.00	10.01.00	2089	mostly grenadiers
22	9	455	990	03:00	58.00.00	14.31.00	58.09.12	14.23.00	901	broken bridle
23	9	1021	2268	03:00	58.09.00	14.26.00	58.05.00	14.42.00	397	sebastes mentella
24	9	576	1278	03:30	58.03.00	14.46.00	58.12.75	15.03.21	1085	argentines
25	9	756	1550	01:45	58.21.49	13.58.74	58.23.00	14.10.44	581	went fast
26	9	891	1800	02:30	58.26.00	14.26.00	58.26.06	14.41.00	1751	mostly grenadiers
27	9	936	2250	03:05	58.26.00	14.38.00	58.27.57	14.21.89	1781	mostly grenadiers
28	10	810	1710	01:10	57.09.33	13.06.29	57.06.55	13.09.80	695	fast in coral
29	10	950	1899	01:00	57.05.00	13.09.00	57.05.26	13.11.91	721	much coral
30	11	896	1980	01:40	56.27.83	14.04.23	56.23.64	14.09.14	731	came fast
31	11	958	2160	01:10	56 23.00	14.07.00	56.26.55	14.03.62	689	came fast
32	11	684	1440	00:30	56.27.00	14.13.00	56.25.00	14.13.00	91	came fast
33	11	196	540	04:40	56.40.00	14.20.00	56.40.45	14.18.99	0	gurnards & haddock

Table 3 Species identified on the 1993 deep water surveys. Classifications after Whitehead et al. (1986)

COMMON NAME	SCIENTIFIC NAME AND CLASSIFICATION	OCCURRENCE	COMMENTS
SHARKS	**SELACHII**		
CATSHARKS	SCYLIORHINIDAE		
blackmouth catshark	*Galeus melastomus*	common	
catshark	*Apristurus spp.*	locally common	Taxonomy under review
DOGFISH SHARKS	SQUALIDAE		
Portuguese dogfish	*Centroscymnus coelolepis*	common	
leafscale gulper shark	*Centrophorus squamosus*	common	
birdbeak dogfish	*Deania calcea*	common	
kitefin shark	*Dalatias licha*	not common	
longnose velvet dogfish	*Centroscymnus crepidater*	common	
velvet belly	*Etmopterus spinax*	common	
ROUGH SHARKS	OXYNOTIDAE		
sailfin roughshark	*Oxynotus paradoxus*	rare	
RAYS	RAJIDAE		
round ray	*Raja fyllae*	common	
blue ray	*Breviraja caerulea*	rare	
deep-water ray	*Raja bathyphila*	common	
longnosed skate	*Raja oxyrinchus*	common	
RABBITFISH	CHIMAEREA		
rabbitfish	*Chimaera monstrosa*	common	
large eyed rabbitfish	*Hydrolagus miriablis*	common	
BONY FISHES	**PISCES**		
SMOOTHHEADS	ALEPOCEPHALIDAE		
Bairds smoothhead	*Alepocephalus bairdii*	common	
Rissos smoothhead	*Alepocephalus rostratus*	common	
bluntsnout smoothhead	*Xenodermichthys copei*	common	
SEARSIDS	SEARSIDAE		
	Searsia spp.	not common	not identified to species
VIPERFISH	CHAULIODONTIDAE		
Sloanes viperfish	*Chauliodus sloanei*	rare	
SCALY DRAGONFISH	STOMIIDAE		
none	*Stomias boa ferox*	not common	

Table 3 Continued

COMMON NAME	SCIENTIFIC NAME AND CLASSIFICATION	OCCURRENCE	COMMENTS
ARGENTINES	ARGENTINIDAE		
greater argentine	*Argentina silus*	common	
LANTERNFISHES	MYCTOPHIDAE		
	Myctophum spp.	common	not identified to species
BARRACUDINAS	PARALEPIDAE		
none	*Paralepis atlantica*	rare	tentative identification
SAWTOOTHED EELS	SERRIVOMERIDAE		
Beans sawtoothed eel	*Serrivomer beani*	not common	tentative identification
CONGER EELS	CONGRIDAE		
conger eel	*Conger conger*	common	
ARROWTOOTH EELS	SYNAPHOBRANCHIDAE		
	Synaphobranchus spp.	common	not identified to species
SPINY EELS	NOTOCANTHIDAE		
smallmouth spiny eel	*Polyacanthonotus rissoanus*	common	
snubnosed spiny eel	*Notacanthus chemnitzii*	common	
shortfin spiny eel	*Notacanthus bonapartei*	common	
GRENADIERS	MACROURIDAE		
smooth grenadier	*Nezumia aequalis*	common	
roundnosed grenadier	*Coryphaenoides rupestris*	common	
roughsnout grenadier	*Trachyrincus scabrus*	common	
Murrays longsnout grenadier	*Trachyrhyncus murrayi*	common	
blackspot grenadier	*Coelorhyncus coelorhyncus*	common	
softhead grenadier	*Malacocephalus laevis*	common	
Gunthers grenadier	*Coryphaenoides guntheri*	rare	
HAKES	MERLUCCIDAE		
hake	*Merluccius merluccius*	common	
COD FISHES	GADIDAE		
cod	*Gadus moruha*	common	
saithe	*Pollachius virens*	common	
ling	*Molva molva*	common	
silvery pout	*Gadiculus argenteus thori*	common	
blue whiting	*Micromesistius poutassou*	common	
torsk	*Brosme brosme*	common	
forkbeard	*Phycis blennoides*	common	
blue ling	*Molva dypterygia*	common	

Table 3 Continued

COMMON NAME	SCIENTIFIC NAME AND CLASSIFICATION	OCCURRENCE	COMMENTS
MORIDS	MORIDAE		
morid cod	*Mora moro*	common	
none	*Halargyreus johnsonii*	common	
MORIDAE	MORIDAE		
none	*lepidion eques*	common	
none	*Antimora rostrata*	rare	
none	*Laemonema latifrons*	rare	tentative identification
MELANONIDS	MELANONIDAE		
none	*Melanonus zugmayeri*	rare	tentative identification
CARISTIDS	CARISTIIDAE		
none	*Platyberyx opalescens*	rare	tentative identification
TRACHICHYIDS	TRACHICHTHYIDAE		
orange roughy	*Hoplostethus atlanticus*	locally common	
silver roughy	*Hoploststhus mediterraneus*	common	
none	*Hoploststhus cadanata*	rare	
SEA BREAMS	BERYCIDAE		
sea bream	*Beryx decadactylus*	common	
MELAMPHIDS	MELAMPHIDAE		
	Melamphaes spp.	rare	not identified to species
OREOS	OREOSOMATIDAE		
false boarfish	*Neocyttus helgae*	not common	
APOGONIDS	APOGONIDAE		
cardinal fish	*Epigonus telescopus*	common	
SCABBARD FISHES	TRICHURIDAE		
black scabbard	*Aphanopus carbo*	common	
silver scabbard	*Lepidopus caudatus*	rare	
ZOARCIDS	ZOARCIDAE		
none	*Lycodes atlanticus*	not common	
BLACKFISHES	CENTROLOPHIDAE		
none	*Schedophilus medusaphagus*	rare	
blackfish	*Centrolophus niger*	rare	
SCORPIONFISHES	SCORPAENIDAE		
none	*Trachyscorpia cristulata echinata*	locally common	

Table 3 Continued

COMMON NAME	SCIENTIFIC NAME AND CLASSIFICATION	OCCURRENCE	COMMENTS
SCORPIONFISHES	SCORPAENIDAE		
bluemouth rockfish	*Helicolenus dactylopterus*	common	
redfish	*Sebastes mentella*	locally common	
FATHEADS	PSYCHROLUTIDAE		
pallid sculpin	*Cottunculus thomsonii*	not common	
FLATFISH	SCOPHTALMIDAE		
megrim	*Lepidorhombus bosci*	common	
megrim	*Lepidorhombus whiffiagonus*	common	
	PLEURONECTIDAE		
WITCH	*Glyptocephalus cynoglossus*	common	
ANGLERFISH	LOPHIIDAE		
monkfish	*Lophius piscatorius*	common	